

Native Fish Conservation in the North Fork Blackfoot River Watershed

Piscicide Implementation Plan



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1 Introduction

This document describes the methods and equipment necessary for efficient and effective removal of nonnative fish from the North Fork Blackfoot River native fish conservation project area, within the Scapegoat Wilderness (Figure 1). A 50-ft high waterfall, known locally as the North Fork Falls, provides a barrier preventing reinvasion of nonnative fishes into the project area. Currently, the project area supports Rainbow Trout × Cutthroat Trout hybrids, with Rainbow Trout providing the predominant genetic contribution.

The project area is an ideal location for conservation of native Westslope Cutthroat Trout (WCT), as it provides an estimated 67 miles of interconnected, fish-bearing stream habitat, and 3 connected lakes. The spatial extent, variety of habitat types, and high elevation will allow for large populations, gene flow, expression of migratory life-history strategies, and a cold thermal regime. Combined, these factors will promote the persistence of WCT in an area that is likely to provide cold water refugia and resiliency to climate change (Isaak et al. 2015).

The proposed action is a native species conservation project with 2 goals:

- Eliminate a source of nonnative genes to the Blackfoot River watershed.
- Reestablish a conservation population of WCT in the project area with less than 10% genetic admixture with nonnative trout.

Accomplishing the goal of nonhybridized to slightly hybridized WCT will require eradicating, or substantially suppressing, the existing fish population, followed by restocking of native trout. Given the spatial extent and complexity of the habitat within the project area, this level of removal will be challenging. This document provides the strategy to maximize the removal of the existing fish populations, which is one component of meeting the genetic goal for WCT. Moreover, the large number of fish that will be restocked into the project area will vastly outnumber any remaining fish. This technique will genetically and competitively overwhelm the sparse remaining hybridized fish, if any, which will further diminish their genetic contributions.

2 Procedures

2.1 *Pre-Project Planning*

Pre-project planning comprises the initial steps needed to define the project area and develop a conceptual approach to guide the next phases. Several of these tasks have been completed, and a description of findings is included in the narrative.

2.1.1 **Barrier Identification**

Reclaiming streams for native species requires assurance that nonnative fishes cannot invade the project area. An existing waterfall within the Scapegoat Wilderness provides a natural barrier that will protect the project area from reinvasion of nonnative fishes (Figures 1 and 2).

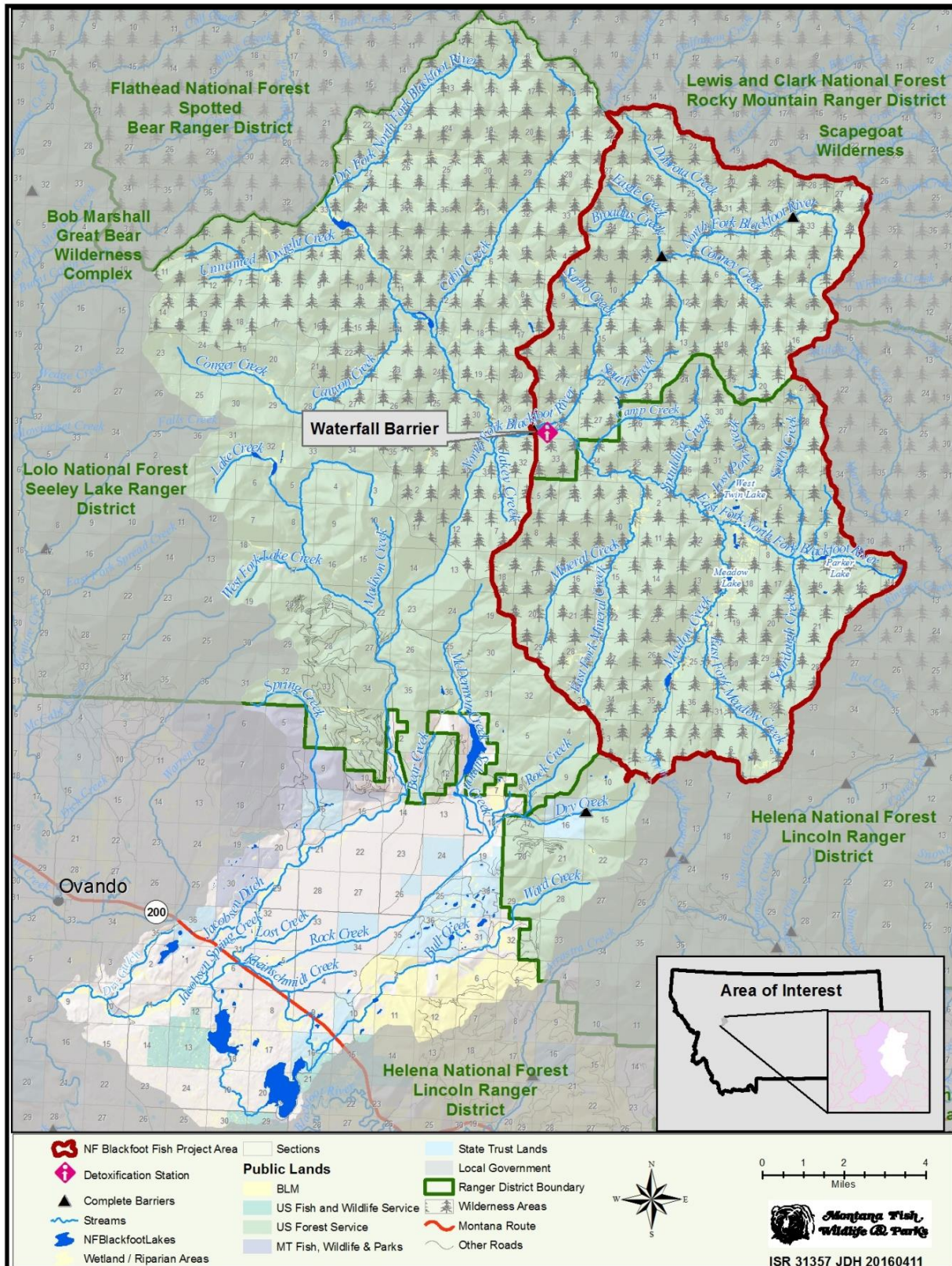


Figure 1. Map of the North Fork Blackfoot River watershed, detailing the project area upstream of the barrier falls.



Figure 2. Barrier waterfall at downstream end of the project area.

2.1.2 Deactivation Station

FWP's piscicide application protocol (MFWP 2017) requires deactivation of rotenone near or at the downstream end of the project area. Potassium permanganate (KMnO_4) is a strong oxidizer that degrades the rotenone molecule within $\frac{1}{2}$ hour of contact time. The proposed location selected for this procedure is 0.5 miles upstream of the barrier falls, and immediately downstream of junction of the North Fork and East Fork of the North Fork Blackfoot River. The volume of water to be deactivated will require a power volumetric feeder to dispense the potassium permanganate. Because the deactivation station is within designated wilderness, the U.S. Forest Service (USFS) will need to approve the action through the National Environmental Protection Act (NEPA) scoping and environmental assessment procedure, with emphasis on the potential for the use of the power feeder to diminish wilderness values or constitute "trammeling" as defined under the Wilderness Act of 1964 and amendments.

To prevent toxic concentrations of rotenone from carrying beyond the project area, the deactivation station must be 30 minutes streamflow travel time upstream of the barrier falls, as potassium permanganate breaks rotenone down into nontoxic compounds within 30 minutes of exposure. In 2016, an initial dye test was conducted at the proposed deactivation station, and the travel time exceeded 30 minutes. Additional dye tests will be completed before treatment to account for variability in flows and to determine the travel time between the deactivation site and the waterfall. If travel time is less than 25 minutes from the junction to the falls at the time of treatment, the deactivation station will be moved upstream the appropriate distance into the fork being treated in order to achieve 30 minutes travel time.

This will be done to avoid residual levels of KMnO_4 higher than 1 ppm that would likely result from a shorter travel time interval, and which could be toxic to fish downstream of the falls following prolonged multi-day exposure.

Determining the concentration and duration of potassium permanganate to be applied, and the quantity required to meet these targets, are other requirements. Stream discharge at the barrier falls is one of the parameters necessary to quantify potassium permanganate needed for deactivation. FWP piscicide policy requires at least twice the estimated quantity of potassium permanganate be available for deactivation. For example, if stream discharge at the falls is 60 cfs, and we estimate the application rate of potassium permanganate will be 3 ppm for a duration of 80 hours, 6,500 pounds of potassium permanganate would need to be on-site, requiring transport of 118 containers of potassium permanganate to the deactivation station. Existing data on stream flow show flows at the barrier falls in August and September ranging from 40 to 78 cfs (Pierce et al. 2018). Refining the estimate of the amount of potassium permanganate required for deactivation will be based on baseline data of discharge at the waterfall, monitoring of snowpack from the previous winter, and monitoring the timing of snowmelt and resulting runoff in the months before treatment.

2.1.3 Identify Fish Distribution

The hybrid trout with a high proportion of Rainbow Trout admixture is the species targeted for removal in the North Fork Blackfoot River and are likely the only species currently occupying the project area. Extensive, basin-wide sampling over the years yielded a single sculpin about a decade ago. Repeated and targeted sampling since has not yielded any sculpin; however, eDNA samples have been collected to test for presence of sculpin. Sculpin are typically absent upstream of large barriers, and a single sculpin could have been the result of release of bait fish by anglers. Nevertheless, the results of the eDNA sampling, combined with electrofishing data, will determine if the project area supports a population of sculpin.

Multiple lines of evidence have been used to estimate Rainbow Trout distribution in the project area, which include electrofishing surveys and eDNA sampling throughout the watershed (Pierce et al. 2018). Physical factors, such as colder water temperatures in headwaters, appear to limit Rainbow Trout abundance. Field surveys found fish in 3 lakes, and these lakes are connected to streams. Recent eDNA surveys in 2019 revealed the presence of hybrid trout near the headwaters in multiple tributaries. In many cases, fish were present well above the predicted fish distribution from the previous model (see Pierce et al. 2018) that extrapolated trout densities based on temperature and habitat metrics. Because of discrepancies between modeled distribution and recent eDNA results, it is now estimated that fish occupy about 67 miles of stream habitat.

2.1.4 Measure Stream Flow throughout Watershed

In 2013 and 2014, the USFS measured stream flows at 19 sites throughout the project area (Figure 3). These measurements were taken in 2013, when flows were below average, and in 2014, when flows were above average. Linear regressions for discharge and drainage area were developed for monitoring stations in the project area to predict a range of discharge across the watershed and across the project area (Figure 4). The results of the 2013 prediction were calibrated using stream flow data collected at the U.S. Geological Service gage on the North Fork Blackfoot River near Ovando (USGS 12338300). This calibration estimated that the 2013 measured discharge was approximately 18% lower than average of the greater North Fork Blackfoot River. These analyses provide a basis to estimate average basin discharge as well as quantities of liquid rotenone and potassium permanganate required for treatment and deactivation. These quantities need to be determined early in the year before treatment to ensure sufficient amounts of these chemicals are procured.

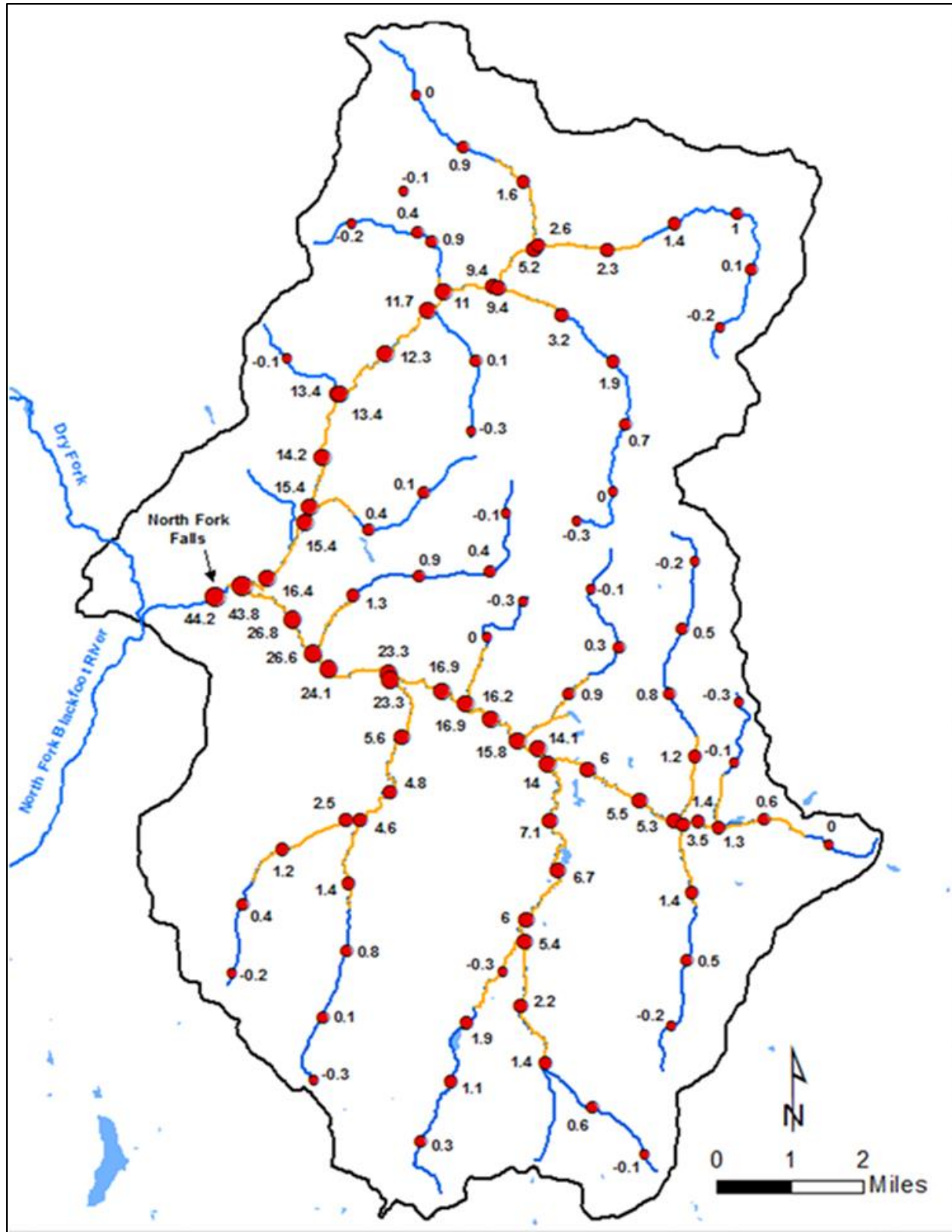


Figure 3. Stream flow monitoring stations and results at stations within the project area. The numbers represent predicted 2013 stream discharge (by stream mile). The orange lines show the general distribution of hybrid fish and the blue lines shows the perennial streams that are currently identified as non-fish bearing.

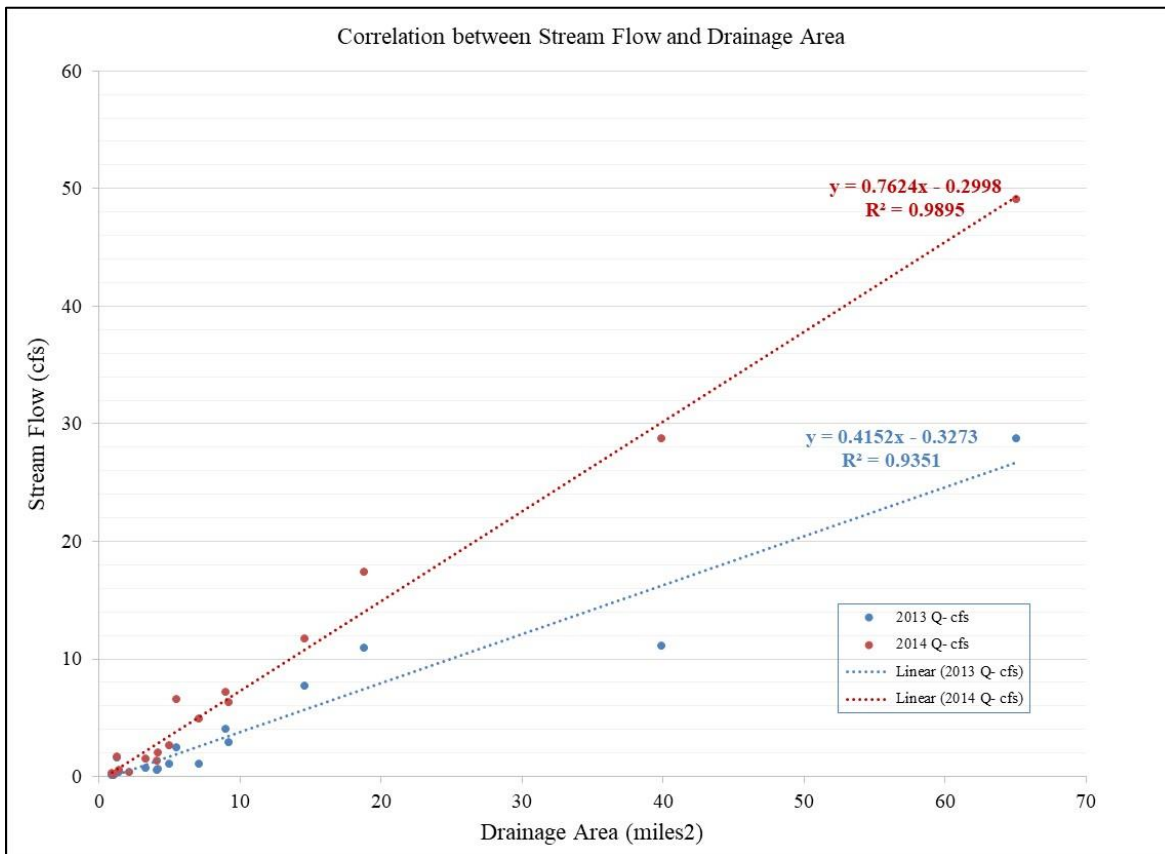


Figure 4. Relationship between discharge and drainage area for stream flow monitoring stations in the North Fork Blackfoot River project area in 2013 (a low flow year) and 2014 (a high flow year).

2.1.5 Field Reconnaissance

Numerous features may impede piscicide application, provide refugia for fish, or otherwise complicate a piscicide project. Examples include areas of dead fall timber that are difficult to traverse, or seeps and springs that dilute piscicide or provide a refuge from lethal concentrations. Beaver dams are common in the watershed, and depth and complexity of the habitat affect the ability to attain target concentrations of liquid rotenone within beaver impoundments and prevent the dispersal of liquid rotenone throughout the beaver dam pool. In 2017, a field expedition of experienced piscicide applicators spent 3 days in the project area to identify and map these features. In 2018, bioassays were conducted in four tributary locations in the East Fork of the North Fork to assess how the piscicide rotenone performed in the different habitat and water chemistry types; to assess the effectiveness of the deactivating agent, potassium permanganate (KMnO₄); and to ground-truth the estimates of fish distribution in select streams. In 2019, aerial reconnaissance of the project area was completed, additional eDNA samples were collected to refine the fish distribution model, and a beaver-dam breaching trial was conducted to assess the feasibility of manipulating beaver dams throughout the project area.

2.1.6 Bioassays

Bioassays are field studies of toxicity of varying concentrations of chemicals and the duration chemicals remain lethal to fish in receiving waters. Bioassays were conducted using liquid rotenone and potassium permanganate. Two types of bioassay for liquid rotenone are conducted simultaneously – the travel time and serial dilution bioassays. Combined, the bioassays provide information to develop treatment protocols

and allow estimation of the amount of residual rotenone at the terminal end of each treatment interval. Moreover, the results will refine estimates of the amount of rotenone required to treat streams in the project area.

The travel time bioassay determines the duration that liquid rotenone remains lethal, which allows determination of spacing between drip stations. This bioassay entails several actions. A nontoxic, fluorescent green dye applied to streams allows determination of the distance the stream flows within specific reaches over 30-minute intervals. The dye is periodically replenished as it disperses and dilutes, so that it remains visible. Sentinel fish are deployed at the 30-minute travel time stations. A single drip station dispenses liquid rotenone to achieve the desired in-stream test concentration. The point furthest downstream where 100% of sentinel fish succumb to rotenone within 4 hours exposure provides the maximum spacing for drip stations during treatment.

In 2018, rotenone was applied in Blondie, Scotty, Sourdough and the East Fork of Meadow creeks to assess piscicide performance in the different habitat and water chemistry types using bioassays of live cutthroat trout, and concurrently to ground-truth the estimates of fish distribution in those streams. At all three locations (Blondie, Scotty and Sourdough creeks) where bioassays were conducted at 1 ppm CFT Legumine, regardless of apparent organic load of the stream, we found this concentration to be ineffective, achieving mortality of sentinel fish no further than 30 minutes downstream from the application point. The East Fork Meadow Creek bioassay was conducted at 2.75 ppm CFT Legumine. Sentinel fish as far as 3 ½ hours below the application point succumbed during the bioassay, while 3 of the 5 sentinels at the 4-hour station were dead the next morning. Due to the ineffectiveness of 1 ppm, and based on the bioassay results at East Fork Meadow Creek, we believe the minimum rotenone formula concentration we would need to apply to the streams to effectively remove the existing non-native trout would likely be at least 2 ppm (0.1 ppm or 100 parts-per-billion (ppb) active ingredient (a.i.)) throughout most of the project area and would probably need to be as high as 4 ppm (0.2 ppm a.i.) in locations that have a high instream organic load.

The serial dilution bioassay determines the lowest concentration of liquid rotenone that is lethal to fish within the receiving waters. Fish are held in separate buckets with varying concentrations of liquid rotenone. For example, treatment concentrations may be 0.5, 0.25, 0.13 and 0.065 ppm of liquid rotenone formulation. The results of the travel time and serial dilution bioassays allow determination of the concentration of liquid rotenone to be applied and the spacing of drip stations. During the serial dilution bioassay conducted with Meadow Creek water, a concentration of 0.25 ppm CFT Legumine (0.0125 ppm or 12.5 ppb rotenone) was found to be the Minimum Effective Dose (MED) necessary to achieve a complete kill of test fish within 4 hours of exposure (Table 1). Standard Operating Procedure 5.1 (SOP 5.1) in the Rotenone SOP Manual produced by the American Fisheries Society recommends treating target waters at a rate at least double the MED to achieve a complete kill (Finlayson et al. 2018). Doubling the MED would result in application of 0.5 ppm CFT Legumine to the streams. This generic prescription is meant to account for degradation of rotenone and variation in sensitivities of individual fish, but is inferior to site-specific information as gathered here, which indicates greater than 50% loss of rotenone in an hour's travel time on all streams. Ideally, the MED should be achieved not at the point of application, but at the farthest downstream point where fish are expected to die from that application, typically immediately above the next drip station.

In 2018, a single test with KMnO_4 was applied to the East Fork of the North Fork in order to test the organic demand of the water and stream channel materials. The stream section used for the test mostly consisted of a streambed with gravels and cobbles but included a breached beaver dam where a considerable amount of organic material had deposited. KMnO_4 was applied at a rate of 3 ppm for 4 hours and 8 minutes, with residual KMnO_4 measured at 15, 30 and 45-minutes travel time downstream of the application station. Concentrations of KMnO_4 continued to rise at all locations over time, reflecting a

trend toward reduction of available organic material in the stream channel. The KMnO₄ test to determine organic demand showed a loss of 2.3 ppm KMnO₄ (3.0 to 0.7) to the 30-minute travel time mark.

Table 1. Lakes, lake volumes, and gallons of rotenone required to treat each lake.

Lake	Volume (acre-feet)	Gallons of Rotenone to achieve 1 ppm
Parker Lake	68.9	23.0
Lower Twin Lake	11.6	3.9
Meadow Lake	17.8	5.9
Total		32.8

Streambed materials at the deactivation site for the treatment (junction of the forks to the falls) are largely cobbles, boulders and bedrock, and little organic material. Therefore, organic demand will likely be less than the 2.3 ppm measured in the East Fork, but can be viewed as a “worse-case” scenario for what will be needed during the treatment. For planning purposes, SOP 7.1 of Rotenone manual recommends calculating the KMnO₄ application rate based on the sum of the oxygen demand plus 1 ppm to deactivate the rotenone plus 1 ppm for a residual at the end of the 30-minute contact zone. Therefore, in this case the application rate used for planning purposes will be 4.3 ppm KMnO₄.

2.1.7 Ground-Truth Fish Distribution Estimate

Extensive fish population surveys, eDNA sampling, and water temperature monitoring in the North Fork Blackfoot River project area were used to estimate the distribution of fish within the basin’s streams, with 67 of the 85 miles of perennial stream habitat estimated to support fish (see 2.1.3 Identify Fish Distribution). In the 2018 bioassay, crews applied rotenone at a single point approximately 1-hour travel time upstream of the estimated extent of fish distribution to assess the validity of the model within select streams. Given the inconsistency of the original model (see Pierce et al. 2018) to accurately predict fish distribution, additional eDNA sampling was conducted in 2019 within primary East Fork tributaries. In select streams, samples were taken at the point of predicted fish distribution, a point near the headwaters, and an intermediate point. All the samples were positive in Meadow, Mineral, East Fork Mineral, and Lost Pony creeks. Furthermore, the point above the predicted distribution in Scotty Creek and Blondie Creek were positive, but eDNA did identify fish barriers within both of those creeks. The eDNA results suggest the original fish distribution model underestimated distribution in many streams, so we currently estimate that fish are present in approximately 67 miles of stream.

2.2 *Piscicide Treatment*

Piscicide treatment is anticipated to begin in 2021 and may be repeated within the same year. The strategy developed under 2.3.2 Coordinating Treatment will provide more specific detail; however, the substantial amount of baseline data on fish distribution, stream travel time, eDNA sampling, stream discharge, and field reconnaissance allows for development of the following recommendations for implementing the piscicide application portion of the project.

As the project is in designated wilderness, the approach for all components of the project will be evaluated through USFS’s minimum requirements decision guide (MRDG) process (Appendix B). The MRDG evaluates if the action is necessary, and if so, the MRDG determines the minimum activity to achieve project goals. Numerous factors are considered in identifying the minimum activity, including time constraints and descriptions of alternatives. The alternatives are broken down into discrete components, or phases, called components of the action. The logistics of how each of the components of action would be performed are the component activities, and the effect of each component activity is

evaluated for the effect it would have on the qualities of wilderness character. The qualities of wilderness character evaluated for each component activity include untrammelled, undeveloped, natural, solitude or primitive and unconfined recreation, and other features of value.

Piscicide projects are complex, and personnel implementing the project will be assigned numerous tasks. The major tasks and likely personnel needs are described in Table 2. These estimates are based on field reconnaissance in 2017-2019. Factors such as number and size of beaver dams found in the project area will determine the number of people and number of days for specific tasks.

Table 2. Major tasks, estimated number of days and number of people to complete the task per treatment.

Task	Number of People	Number of Days
Project oversight	3	Every day
Transport of materials (in and out by helicopter)	4	4
Transport of materials (in and out by pack train)	33	14
Project implementation	30	24
Breaching beaver dams		
Dye testing		
Electrofishing and sentinel fish deployment		
Tending rotenone stations		
Backpack spraying		
Deactivation	4	5

Communication among personnel and project leaders is critical in promoting project success and safety. Typically, the U.S. Forest Service supplies radios and batteries to fieldworkers. Given the large project area, this project will be of considerable duration, and a sufficient supply of batteries or battery chargers will be needed. If the radios have rechargeable batteries, a generator may be necessary to power the battery chargers. In addition, portable repeaters will be needed to allow communications throughout the large project area.

2.2.1 Transport and Staging of Supplies

The North Fork Blackfoot River project area is in rough, remote terrain, within designated wilderness. This strategy for moving supplies, equipment and personnel throughout the project area is based on experience in implementing large-scale piscicide projects in remote country and in the Bob Marshall and Lee Metcalf Wilderness areas. For these projects, motorized, mechanized, and aerial support was approved to transport and stage supplies, apply piscicide in lakes, and re-stock lakes with native trout. The type of mechanized support will be determined through the NEPA/MEPA process; however, horse or mule trains and helicopter assistance will be the likely modes of transport for this project.

Piscicide application projects entail a considerable amount of gear, chemicals, and associated supplies. Project materials, personal gear, and chemicals will be transported into the project area on foot- or, horseback, or by helicopter, with aerial support required to transport large, heavy or awkward items, or items that are too numerous, or too risky, to be transported by other means. Field reconnaissance will inform development of plans to transport and stage the diversity of gear and supplies required to support piscicide treatment in 2019.

Specific materials and gear to be transported into the deactivation area are as follows:

- FWP piscicide policy requires 2 independent deactivation systems. The smallest and simplest of these systems is a volumetric feeder that weighs about 80 pounds, plus at least 3 gas powered generators, such as a Honda 2000 or 2200. Alternative systems include larger and heavier feeders,

with the same support system as the small feeder, and two 200-gallon water tanks that require a 2-inch gas-powered pump to fill them.

- At least 2 times the amount of potassium permanganate estimated to be necessary to deactivate rotenone must be transported to the deactivation station.
- Support equipment needed to operate the power feeder and apply potassium permanganate include motorized pumps, gas-powered generators, and fuel.
- Support equipment necessary to operate the 200-gallon tank system includes primary and back-up 2-inch water pumps, hoses, irrigation supply boxes, a sump pump to mix potassium permanganate in the tanks and fuel.

Parameters used in estimating the quantity of liquid rotenone required for the project are length of stream to be treated, results of bioassays, and stream flow. Stream flow monitoring in August 2013 (Figure 3) provided the basis for an initial estimate of the quantity of piscicide required to treat streams in the project area; however, stream flow measurement as close as possible to the treatment period will provide the final estimate of quantities needed. Stream flow measurement in August 2017 yielded an estimated need for 270 gallons of liquid rotenone.

Three fish-bearing lakes are in the project area and will be treated with rotenone (Table 1). The volume of water in the lake dictates the amount of rotenone required to treat the lake. One gallon of liquid rotenone will treat 3 acre-feet of water to 1 ppm of rotenone formula, which yields a concentration of 0.05 ppm of rotenone. Application of rotenone will require transport of at least 1 inflatable boat, along with small outboard motor to apply and disperse rotenone (Figure 5). We are recommending that 2 inflatable rafts and associated equipment, including small gas-powered outboard motors, be used at Parker Lake to expedite treatment there and insure that rotenone application is completed in one day, and then on a single raft can be transported to each of Twin and Meadow lakes to conduct oar-powered treatments on them. A small battery powered pump will be needed on each raft to disperse piscicide from the pesticide tank into each lake. The use of gas-powered equipment will require transport of gas cans. In addition, backpack sprayers will be used along the margins of lakes and within connected wetlands. An estimated 12 backpack sprayers should be sufficient.

To facilitate development of the MRDG regarding transport of chemical, boats, and associated equipment, FWP estimated the cost of using helicopter support, and the alternative of using wranglers and pack strings to transport equipment and supplies to the detoxification site and treatment supplies to several staging sites within the project area. The necessary equipment and supply distribution could be accomplished with about 20 flights in and out of the wilderness over 2 days, and 15 flights to remove gear after the project has been completed. In contrast, transporting the same materials and gear by pack line would require the equivalent of 33 wranglers and 198 mules. The duration of transport by pack animals would be 2 weeks, as opposed to 4 days of helicopter flights.

The preferred method includes a combination of aerial support to transport materials to the project area with the subsequent use of stock to distribute supplies throughout the project area. The selected alternative from the MRDG (Appendix B) would enable helicopter transport of rotenone and detox chemicals, and equipment associated with the detox station. Other supplies and equipment without safety risks and weight constraints will be transported with stock. Transport of chemicals and detox equipment will require up to 10 flights. This will take a maximum of 2 days. Following completion of piscicide application, transport of surplus chemical and detox equipment will require up to 5 flights over a maximum of 2 days. Proposed flight paths will be selected to avoid high elevation feeding areas that are important to grizzly bears. Given the number of flights needed to go to detox, those materials and the North Fork materials will be flown in from the North Fork trailhead (Figure 6). Project materials for the

East Fork of the North Fork may be flown in from the Indian Meadows trailhead or the North Fork trailhead depending on weather conditions and pilot recommendations.

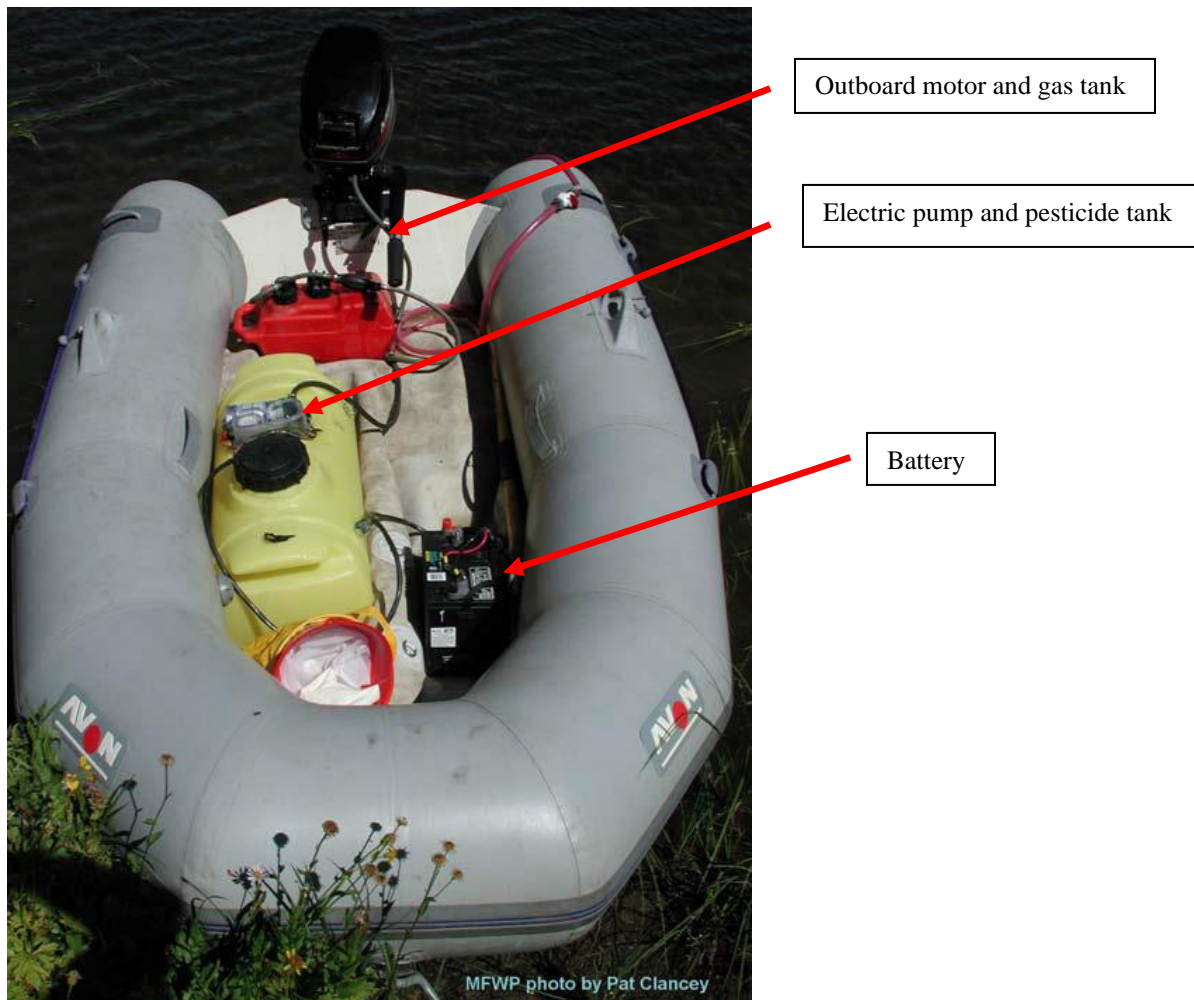


Figure 5. Inflatable raft, gas-powered outboard motor, pesticide tank and battery-powered pump used to apply piscicide to Cherry Lake in the Lee Metcalf Wilderness Area.

There is a possibility of an accident occurring while transporting project chemicals, though the likelihood is small. Loss of control of a pack string, dropping a chemical container while loading or unloading or dropping an aerial load from a helicopter are all possibilities. If an accident occurred, the risk to humans and the environment is slight. Rotenone formulations are packaged in 5-gallon (one hinged metal handle on top of drum) or 30-gallon (no handles) metal drums that may become dented or punctured in an accident, but any leakage could be addressed quickly by simply turning the drum so the leak is up. A catastrophic accidental spill of rotenone is very unlikely and has happened only once in the more than 100 projects conducted by FWP since 1990; that incident involved a 30-gallon drum accidentally dropped by a helicopter on a hillside.

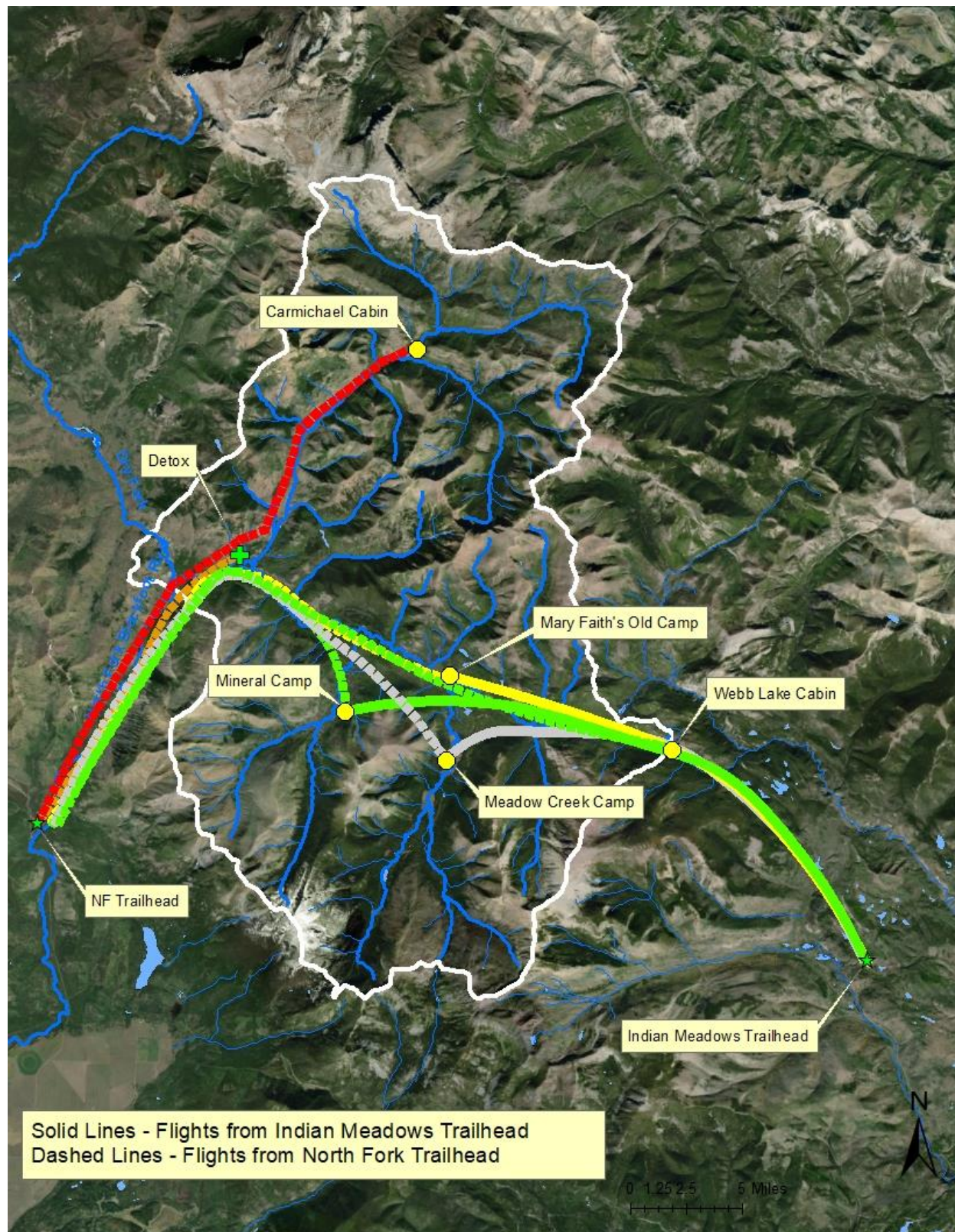


Figure 6. Map of potential flight paths to transport equipment to and from the project area.

If a spill occurred in the water, it would likely be due to an accident during transport as described above. Spills during the treatment would be very minor and restricted to individual drip buckets or backpack sprayers. This is because storage of rotenone containers in the treatment area will either be in areas that do not drain to waters, or within bermed enclosures to capture spilled material (SOP 4.1). Similarly, transferring of rotenone from drums to service containers must be done within a secondary containment area to capture all spills and drips. In the event of spills to water, depending on the rate of liquid rotenone leaking from a drum or drums, the effects could range from similar to the desired treatment effects to catastrophic for susceptible aquatic organisms.

The bioassays conducted in 2018 showed that effective liquid rotenone concentration ranged from 1 to 3 ppm, depending on a stream's specific characteristics. If leakage resulted in instream liquid rotenone concentrations significantly higher than necessary for that specific stream, the most significant impact would likely be decimation of the aquatic invertebrate population, and possibly of some amphibian mortality. If a catastrophic spill happened relatively near the waterfall or confluence of the North Fork and East Fork of the North Fork, sufficient rotenone could pass the waterfall to cause mortality below the waterfall, including to Bull Trout. In any event, the rotenone would dissipate as it carried downstream, and since there would not be a series of sites where rotenone was being applied as would occur during a systematic treatment, the deleterious effects would be dependent on the concentration of liquid rotenone actually in the water. To minimize the potential effects of an accidental spill of any volume, we will transport all detox equipment and supplies to the detox site and have a crew immediately begin setting up detox so it is operational as rotenone is being transported throughout the project area. Additionally, we will design flight paths that avoid sustained periods of travel over the major streams.

If rotenone spilled onto the ground or a rocky area, it would absorb into the soil or coat the rocks. In such an instance the contaminated soil will be removed, placed in a plastic bag, within an enclosable container and transported to an appropriate landfill for disposal.

Potassium permanganate (KMnO_4) is packaged in shatter-resistant plastic drums with expansion ring closure of the lids. Each drum weighs about 58 lbs (55.175 lbs KMnO_4 plus the drum weight) and has two collapsible handles. A spill of a relatively significant quantity of KMnO_4 into a given volume of water would result in mortality of a wide range of aquatic organisms including fish, aquatic insects and juvenile and adult amphibians. A spill of a relatively minor quantity of KMnO_4 into a given volume of water would result in little more than a coloring of the water. If spilled on soil or among rocks, the KMnO_4 will be scooped up with a shovel and repackaged for use or disposal.

Costs associated with helicopter transport versus pack animals are considerably different. The estimated cost for 40 hours of helicopter time is \$19,000, whereas the estimated cost for the necessary pack strings and wranglers is \$38,300. Once staged, the equipment and supplies would be distributed throughout the project area as necessary by pack strings and project workers.

Drip stations are the primary method of dispensing rotenone to streams, and up to 30 drip stations (see 2.2.6 Drip Stations) will need to be transported to and throughout the project area. These would be distributed by fieldworkers and/or pack animals. Seeps and small springs are best treated with a mixture of dry rotenone powder, sand and dry gelatin. This project will require several 5-gallon pails of this mixture be available throughout the project area. In the larger discharge streams, such as the North Fork and East Fork, liquid rotenone may be dispensed into the stream directly from a 5-gallon rotenone drum fitted with a spigot to control the flow rate.

Support supplies include personal gear, food, and kitchen supplies for fieldworkers, and these materials will be transported by pack lines throughout the project area, after being delivered to staging areas. To distribute fieldworkers throughout the project area, camp sites will be established in the east and north

forks of the Blackfoot River and equipped with a kitchen tent, food, and cooking supplies. Personal gear will include tents, sleeping bags, head lamps, batteries, and other basic camping equipment.

Using existing cabins and outfitter camps will reduce disturbance associated with housing and feeding fieldworkers. As the piscicide treatment will proceed from headwaters to downstream, camps will need to be mobile. Possible scenarios entail moving from existing cabins and camp sites to others downstream. On the East Fork North Fork Blackfoot River, fieldworkers may initially set up camp at the Webb Lake cabin, and then move to the Meadow Creek outfitter camp as the treatment proceeds downstream, and finally move to a satellite camp. On the North Fork Blackfoot River, fieldworkers may initially camp at the Cooney Creek cabin and then move to a satellite camp.

2.2.2 Spike Camps

Spike camps may be necessary to facilitate treatment in some areas of the drainage that are several hours travel from existing Forest Service and outfitter camps or Forest Service cabins (Figure 7). We expect any spike camps will not exceed 15 people. Furthermore, personnel in outfitter camps and spike camps will adhere to Forest Service *Food Storage Special Order LC00-18*. A spike camp near the mouth of Blondie will facilitate treatment of Parker Lake, Blondie Creek, Scotty Creek, Sourdough Creek, and the East Fork below Parker Lake. A spike camp located at Mary Faith's old outfitter camp will facilitate treatment of lower Meadow Creek and the East Fork. The Lost Pony spike camp could be used for the West Twin Lake and Lost Pony Creek treatments. An existing camping area near the mouth of Mineral Creek could be used as a spike camp for treatment of lower Mineral Creek and the East Fork down to detox. If needed, an existing camping area upstream of the mouth of Sarbo Creek could support personnel working between the detox station and the Theodore outfitter camp.

2.2.3 Coordinating Treatment

The treatment strategy is a synthesis of the activities described in this document. Components of planning associated with the field crew include safety, treatment logistics, and location of concentrated staging and camping areas. Proper chemical management must also be determined with identification of on-site storage areas and description of secondary containment and transfer devices. Planning associated with chemicals and personnel must incorporate effects on the landscape, with emphasis on limiting disturbance and protecting sensitive natural resources. This portion of the strategy must also ensure radio repeaters are in place for 2-way communications throughout the project area.

The strategy also needs to include activities required shortly before application of rotenone. These actions include measuring stream discharge at strategic locations, conducting dye testing to determine the distance water travels in 30 minutes throughout the treatment area, and developing a plan for coordinated treatment of the main stem and tributaries. The approach to deactivating piscicide is another requirement, and includes determining the timing and associated procedures of applying the deactivation agent. Features that may affect the dispersal of rotenone, such as beaver dams, need to be addressed.

2.2.4 Project Oversight

Project oversight will begin with safety training for personnel and end with cessation of application of potassium permanganate within the required criteria for survival of sentinel fish at the downstream end of the project area. A project manager and assistants will supervise field crews, ensure return of all fieldworkers at the end of the day, distribute appropriate quantity of piscicide to applicators for each station, distribute sentinel fish, and maintain communication with all fieldworkers. The project manager and assistants will troubleshoot should problems arise, and assign fieldworkers new tasks as they complete their assigned tasks. The project manager will be a certified licensed applicator for rotenone.

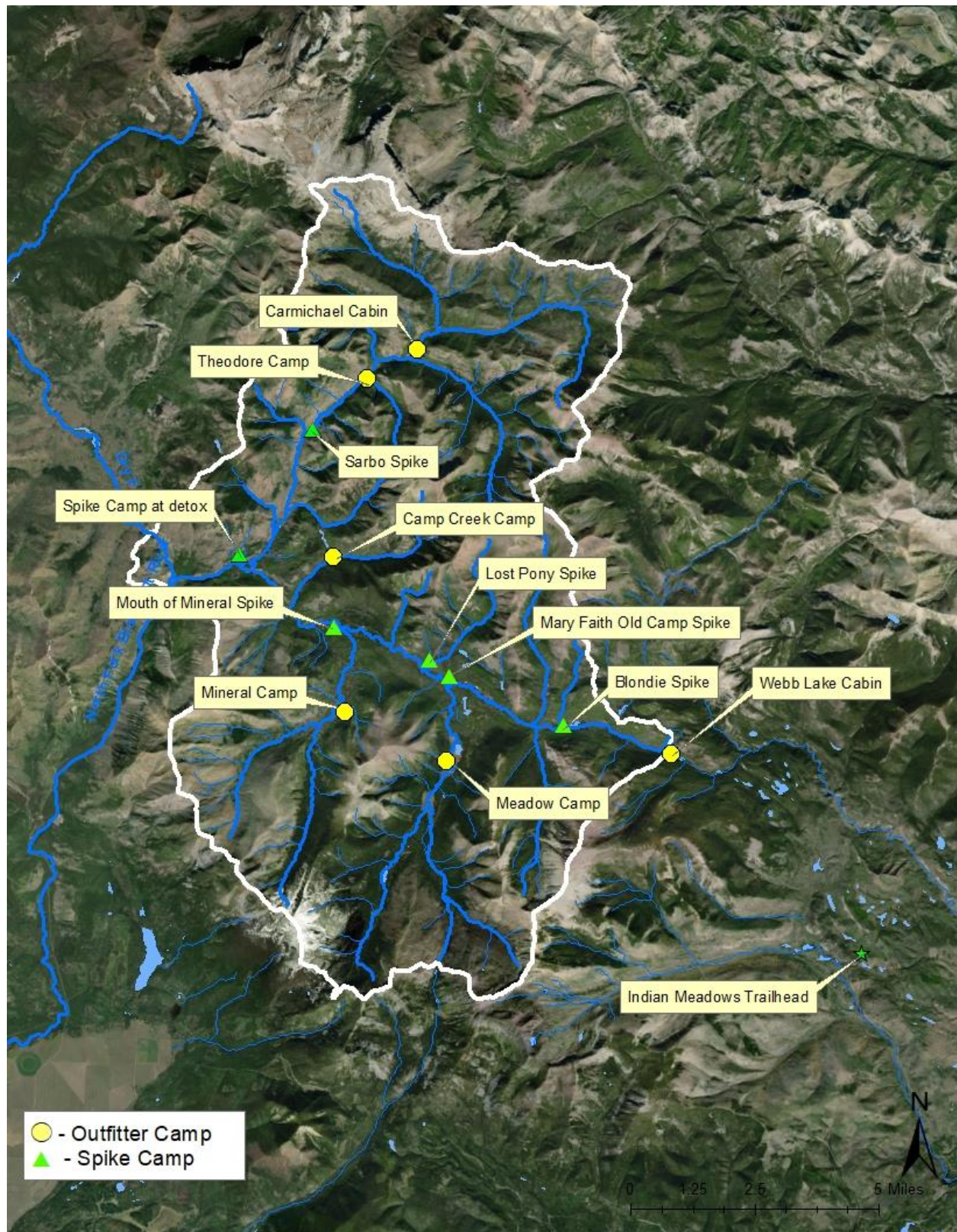


Figure 7. Map of existing outfitter and spike-camp locations that personnel may use during project implementation.

2.2.5 Beaver Dam Breaching

To promote effective dispersal of rotenone, beaver dams will be temporarily breached to dewater large pools that are difficult to treat and can provide refugia with sublethal concentrations of rotenone. As beaver impoundments affect downstream flow rates and create turbidity when breached, beaver dam breaching will occur before dye tests. Breaching will maintain flow through the area during piscicide application. Large beaver dam complexes are present on Meadow Creek, the East Fork of the North Fork between Parker Lake and Meadow Creek, Mineral Creek, and on the East Fork of the North Fork Blackfoot River upstream of Parker Lake. These dams must also be breached to maintain flows until treatment is complete. Field reconnaissance will likely discover additional beaver dams, and these dams will receive the same treatment. No beaver control will occur during the project. Dams will be breached using hand tools (e.g., Pulaskis and mattocks).

The beaver dam investigation in 2019 demonstrated that notching effectively lowered the stream to the pre-impounded elevation and suggested that this effort should be feasible on the project-scale (Figures 8-10). It took a two-person team approximately 20-60 minutes to breach each beaver dam. Time was dependent on the diameter of anchor logs in the dam, as well as the height of the dam. A reconnaissance flight in 2019 identified 3 active beaver dams in Meadow Creek and 6 active dams in Mineral Creek. The East Fork between Parker Lake and the Meadow Creek confluence contained the most potential challenges. It was hard to identify beaver dams from the air given the large amount of woody debris. The impounded areas are likely caused by a combination of debris jams and active beaver dams.



Figure 8. Using a mattock to notch a beaver dam during the breaching investigation, 2019.



Figure 9. Beaver pond draining through the notch in the dam.



Figure 10. Streamflow receded to the pre-impounded active channel after the beaver pond was completely drained through the notch in the dam.

2.2.6 Dye Tests

Before application of Liquid rotenone, dye tests will be conducted on all fish-bearing waters to determine travel time, which will provide the basis of establishing drip station sites, following the travel time bioassays conducted in 2018 (2.2.1 Bioassays). Depending on requirements for safety, workers will work solely or in teams. A nontoxic, fluorescent dye will be released at the location determined to be the uppermost point where rotenone will be applied. The leading edge of the dye is tracked and replenished periodically to maintain an identifiable plume. Flagging is placed at the point of the leading edge at 30-

minute intervals, and GPS coordinates are recorded for each flag. Flagging is labeled with the stream name and sequential numbers in 30-minute increments. For dye tests for rotenone, flags are labeled with the stream name and “0” at the first point of application and as the plume travels downstream, the flags are numbered sequentially with numerals, beginning with 1 at the first point of 30 minutes travel time. For the deactivation station, flags are placed at 30-minute travel time locations and labeled in increments of 30.

Dye testing, sentinel fish distribution, and treatment would begin in the headwaters, and proceed stepwise downstream. Dye testing may be implemented throughout the watershed before application of piscicide, or dye testing may proceed step-wise, with piscicide application following individual dye test efforts. Depending on the distance traveled and scheduling of dye test and rotenone application, the camps may need to be mobile, and treatment may be interrupted by a day to move camps.

2.2.7 Drip Stations

Drip stations are the primary method of dispensing piscicide in streams, and drip stations will be needed in 2018 to conduct bioassays and ground-truth fish distribution estimates. In 2021 and any treatments in subsequent years, drip stations will dispense Liquid rotenone throughout fish-bearing reaches in the project area.

Three types of drip station are used in piscicide projects: 5-gallon water cubes (Figure 11), Montana buckets (Figures 12 and 13), and IV bags (Figure 14). Water cube drip stations are equipped with a standing tube with an aperture that releases 5 gallons (18,925 ml) of liquid rotenone and stream water solution in a thin stream for 4 hours, a rate of 79 ml/minute. The Montana bucket is a 3 ½ gallon bucket with a molded plastic elbow coming out of the bottom. A short length of garden hose attached to the plastic elbow leads to an automatic dog watering bowl. A float system in the bowl maintains constant head. A hole drilled in the bottom of the dog bowl delivers liquid rotenone and stream water solution the stream for 4 hours. Stream water is mixed with the liquid rotenone in both the water cube and Montana bucket system to homogenize the solution and bring each device to its full volume so that it runs for the prescribed duration. The IV bag method entails filling the bag with undiluted liquid rotenone and suspending the bag above the stream. The plastic tubing is adjusted to provide a steady drip into the stream and can be moved higher or lower relative to the IV bag to adjust the flow rate. The flow rate is measured using a small graduated cylinder.

For all drip station types, the amount of Liquid rotenone added to the dispensing container needs to result in maintaining the desired in-stream concentration of rotenone for a minimum of 4 hours. Typically, the target in-stream concentration is 1 ppm of liquid rotenone formula, which results in 0.05 ppm of rotenone. based on the 2018 bioassays, concentrations of liquid rotenone may be less than 1 ppm or as high as 4 ppm.

2.2.8 Piscicide Application

This task will require the efforts of nearly all personnel. Piscicide application includes monitoring drip stations, dispensing dough balls, and spraying lake margins, wetlands and disconnected and marginal stream water with backpack sprayers. One person is assigned to each drip station. Typically, drip stations run for approximately 4 hours.

Drip station spacing during treatment will be determined by results of the travel time bioassays conducted in 2018 (2.1.6 Bioassays) and pretreatment dye tests. The goal is to maintain lethal concentrations of rotenone between drip stations. Fieldworkers assigned to a drip station will monitor sentinel fish placed upstream of a drip station (2.2.9 Electrofishing and Sentinel Fish) and report their status to the project manager.



Figure 11. Five-gallon water cube drip station.



Figure 12. Montana bucket piscicide dispersal system. Note sentinel fish in mesh bag upstream of the rotenone application point.



Figure 13. Close-up of the Montana bucket system trickling Liquid rotenone/stream water solution into a stream. The stream of Liquid rotenone and stream water solution is visible in the yellow box.



Figure 14. IV-bag drip station.

Backpack spraying will augment drip stations by treating off-channel waters and peripheral waters that may be fish-bearing. In addition, spraying may be used on any stream to treat minor stream flow upstream of station 0 established during dye tests. One or 2 fieldworkers may be assigned a specific section of stream to spray, with up to 12 people daily being assigned to spraying. Spraying commences 1 hour after drip stations are started and cover the assigned area twice.

Piscicide treatments are initiated at the upstream point and proceed downstream daily. Block nets are not usually necessary to prevent overnight invasion of treated waters from untreated waters below, as the treatment distance below the lowest drip station is generally adequate to prevent overnight invasion. Treatments are slightly overlapped from day-to-day, which also reduces the probability of reinvasion overnight.

2.2.9 Electrofishing and Sentinel Fish

Sentinel fish will indicate whether lethal concentrations of rotenone are maintained to the next drip station, with drip station spacing based on bioassays. For example, if bioassays determine that rotenone remains lethal for 90 minutes of stream travel time, sentinel fish would be placed at 90-minute intervals. If sentinel fish indicate lethal concentrations are not maintained between stations, intermediate rotenone stations would be deployed to ensure lethal concentrations reach the next station. Intermediate stations would release a lower concentration of rotenone for a shorter duration and be placed midway between stations.

Sentinel fish will be transported to the detox station and basecamps during the helicopter supply flights. Age-0, hatchery-origin WCT (M012 strain) will be used at detox to ensure enough fish are available. In areas with sufficient wild trout abundance, electrofishing may be used to capture wild fish to use as sentinel fish. In the North Fork and East Fork of the North Fork, and in the larger tributaries with lots of complex habitat (e.g., Meadow Creek and Mineral Creek), sentinel fish will be deployed at select drip stations throughout the stream length. In smaller tributaries without trail access, sentinel fish will be deployed at the mouths. Wild sentinel fish can be electrofished and captured the day before treatment. To ensure high survival of M012 sentinel fish held at detox and basecamps, fish will need to be fed on a daily basis and kept in aerated tanks or stored in net-pen enclosures in streams. Depending on hatchery availability, approximately 250-500 WCT will be needed to fulfill sentinel fish requirements.

Disposal of fish carcasses. We recommend that fish carcasses be left to decay in place in the streams and lakes. Generally, fish density is low throughout the project area, so there will not be a large accumulation of carcasses to attract scavengers, including grizzly bears. During previous projects FWP bear managers have recommended leaving carcasses instream, as they felt collecting and burying them would be a more likely attractant to bears than leaving the carcasses scattered instream where decay will occur more quickly than if buried, odors will likely be less noticeable due to being submerged in water, and smaller, more local scavengers will consume them.

Carcasses may accumulate along wind-affected lake shores, so if that occurs it may be necessary to collect the carcasses, deflate their air bladders and sink the carcasses into the deepest offshore areas of the lakes.

2.2.10 Deactivation

Deactivation of rotenone is required under FWP's piscicide policy (MFWP 2017). Potassium permanganate is a strong oxidizer and the deactivating agent used to degrade rotenone. Deactivation of rotenone is typically achieved within 30 minutes of contact with potassium permanganate. The concentration of potassium permanganate applied to streams must meet 3 requirements. The applied concentration must meet the in-stream biochemical demand for the elements in potassium permanganate, it must fully neutralize rotenone within 30 minutes, and it must provide a surplus concentration of

potassium permanganate from 0.5 to 1.0 ppm. The surplus potassium permanganate provides evidence that the other two requirements are met, yet remains at a level that itself is not acutely lethal to fish.

Although FWP's piscicide policy requires limiting the extent of lethal concentrations of rotenone to the 30-minute mixing period, the presence of Bull Trout in the North Fork Blackfoot River downstream of the falls elevates the need to control the area of lethal concentrations. Based on previous dye tests, the preliminary site selected near the confluence of the East Fork North Fork Blackfoot River and the North Fork Blackfoot River will likely allow 30 minutes of contact before flows reach the barrier falls; however, the bioassay process will evaluate this assumption, and the station may need to be moved accordingly. The falls themselves may act to dissipate some of the KMnO_4 , as was seen recently during deactivation above Overwhich Falls in the Bitterroot drainage. If this effect does occur, it would only serve to further reduce KMnO_4 levels below the sublethal levels that will be allowed over the falls during deactivation.

FWP policy also requires that deactivation must begin 2 hours before the estimated arrival of rotenone at the deactivation site. Deactivation is terminated after rotenone is estimated to have passed the deactivation site and when sentinel fish placed immediately above the deactivation station have lived without distress for four hours. Deactivation in watersheds with lakes may be longer than when only stream habitat is treated, depending on the proximity of the lake to the deactivation site. Timing and duration of deactivation will be determined following completion of dye testing prior to the actual treatment.

A highly experienced, licensed applicator will lead deactivation, and will be accompanied by 1 or 2 assistants. Tasks performed include operating the deactivation station, monitoring of sentinel fish, and monitoring residual potassium permanganate at the 30-minute site in the deactivation zone.

A large supply of sentinel fish is necessary to monitor the deactivation process. Initially, sentinel fish are deployed immediately upstream of the deactivation station and at 30-minute water travel time intervals downstream of the station, and stations can extend to the 120-minute interval. The fish upstream of the deactivation site indicate whether a lethal concentration of rotenone reaches the downstream end of the project area. Once the initial batch of sentinel fish have succumbed to rotenone, they are replaced with subsequent batches until sentinel fish survive without distress for the requisite duration, at which time the detox station can be shut down.

2.2.11 Stocking

Given that 100% eradication of hybrid trout is unlikely, rapid stocking of copious WCT to effectively "swamp" (e.g., Leary et al. 2006) the project area is necessary for project success. Shepard et al. (2018) developed a decision-making framework to evaluate alternative scenarios for repopulating the project area following rotenone application. A key consideration for determining how to repopulate the vacant habitat is the selection of life-stage(s) and source(s). To help narrow the decision, the project objectives dictate the need to 1) seed a large majority of the habitat fairly rapidly after the rotenone treatment is completed; 2) replace the lost angling opportunity with a recreational fishery the following summer; and 3) ensure mature, pure WCT are present in the project area during the spawning season following rotenone completion. Remote site incubators (RSI) have been a preferred method for seeding vacant habitat because they allow fish to imprint on natal areas, and natural selection pressures are exerted on individuals at an early age, which helps eliminate the potential hatchery selection when using age-0 and older transplants (Shepard et al. 2018). However, RSIs must be maintained every two to three days for two weeks (Shepard et al. 2018). The broad area that we need to seed rapidly after treatment likely precludes RSIs as a realistic option to accomplish the project objectives.

We need to stock many (>100,000) pure, WCT of multiple life-stages immediately after treatment has completed, so using the captive Washoe Park Hatchery (M012) strain is the most feasible source of fish to

accomplish project objectives. This strain was developed to maintain high genetic diversity to serve as an ideal source for re-founding conservation populations, as well as providing recreational opportunities (Shepard et al. 2018). The advantages of using this strain include the ease of obtaining relatively large amounts of fish, the stable availability over multiple years, and the fact that although it is a captive strain, it retains a high degree of genetic variability (Shepard et al. 2018). Although no genetic contributions by Blackfoot populations are included in this strain, many South Fork Flathead populations are included, which have similar habitats and similar selective pressures, making them adapted for the broader environment within the Bob Marshall Wilderness Complex. Selected stream stocking with Age-1 and Age-2 WCT will occur in areas that currently support the highest densities of fish and might have hybrids remaining after the rotenone application. Individuals from the M012 strain that were stocked in vacant habitat following rotenone treatments have had exceptional survival rates, even higher than some sources of wild, aboriginal donor stocks (Andrews et al. 2016). This is an important consideration given that the population needs to grow and expand rapidly to have the best chance of swamping out any remaining hybrids.

The proposed stocking rates represent an approximate estimate based on swamping requirements and desired trout densities following treatment (Table 3). Specific numbers that are stocked in the project area will depend on hatchery availability, identified needs, and other logistics. Furthermore, the flexibility to conduct these stocking events within a 5-year window, rather than three consecutive years, will be needed to accommodate unforeseen circumstances. Specific stocking locations will be determined during stocking efforts and will be dictated by helicopter ability and travel feasibility. The project area has the predicted habitat potential to support more than 75,000 Age-1+ WCT (Shepard et al. 2018) based on WCT densities observed in reference streams in adjacent drainages. Although stocking this number of fish is not necessary given that seeding of vacant habitat results in exponential population growth (Clancey et al. 2019), it is prudent to err on the high side of seeding rates given that swamping is a desired outcome in certain parts of the drainage. Clancey et al. (2019) documented densities of WCT five years post-project ranging from 0.2 to 1.0 trout/m, which resulted from a seeding rate of 0.5-1.1 fry/m. The post-project densities of 0.2-1.0 trout/m encompass the range of densities observed in reference streams that have similar production potential of streams in the North Fork project area.

Table 3. Estimated stocking rates and comparison of flights (**bold**) and mules (*italicized*) required to transport fish.

Year	2021	2022	2023
Age-0	35,147 (5) (23)	37,817 (5) (25)	37,745 (5) (25)
Age-1	3,726 (5) (25)	1,242 (2) (17)	1,242 (2) (17)
Age-2	3,111 (20) (145)	1,037 (7) (50)	1,037 (7) (50)
Total flights (<i>total mules</i>)	30 (193)	14 (92)	14 (92)

The stocking plan is based on Age-0 stocking rates of 0.69 fry/m divided among one, two, or three years of stocking depending on the size, habitat potential, and swamping priority of the specific tributary (see Table 4 for details). For streams receiving fry in each of the three stocking events, the total annual stocking density is 0.23 fry/m. The stocking plan for catchable-sized trout (Age-1 and Age-2) is divided equally between age classes for a total of 68/km in the first year and 23/km in the second and third stocking events. In total, over 116,000 trout are anticipated to be stocked in the project area (Table 3). This quantity of pure WCT should be sufficient to overwhelm any remaining hybrids after piscicide application and result in trout densities similar to reference populations in adjacent watersheds.

Table 4. Estimated stocking rates of Age-0, Age-1, and Age-2 WCT.

Waterbody	Age Class	2021	2022	2023
North Fork Blackfoot River	Age-0	3,660	3,660	3,660
	Age-1	537	179	179
	Age-2	537	179	179
Dobrota Creek	Age-0	1,049	1,049	1,049
	Age-1	154	51	51
	Age-2	154	51	51
Cooney Creek	Age-0	1,617	1,617	1,617
	Age-1	237	79	79
	Age-2	237	79	79
Cooney Creek unnamed tributary westside	Age-0	444	444	444
	Age-1	0	0	0
	Age-2	0	0	0
Cooney Creek unnamed tributary eastside	Age-0	333	333	333
	Age-1	0	0	0
	Age-2	0	0	0
Broadus Creek	Age-0	0	72	0
	Age-1	0	0	0
	Age-2	0	0	0
Theodore Creek	Age-0	0	888	888
	Age-1	0	0	0
	Age-2	0	0	0
South Creek	Age-0	0	1,229	1,229
	Age-1	0	0	0
	Age-2	0	0	0
East Fork of the North Fork	Age-0	4,220	4,220	4,220
	Age-1	620	207	207
	Age-2	620	207	207
Blondie Creek	Age-0	208	208	208
	Age-1	0	0	0
	Age-2	0	0	0

Meadow Creek	Age-0	2,678	2,678	2,678
	Age-1	393	131	131
	Age-2	393	131	131
East Fork Meadow Creek	Age-0	959	959	959
	Age-1	141	47	47
	Age-2	141	47	47
Scotty Creek	Age-0	1,035	1,035	1,035
	Age-1	152	51	51
	Age-2	152	51	51
Mineral Creek	Age-0	2,114	2,114	2,114
	Age-1	310	103	103
	Age-2	310	103	103
East Fork Mineral Creek	Age-0	1,402	1,402	1,402
	Age-1	206	69	69
	Age-2	206	69	69
Lost Pony Creek	Age-0	1,287	1,287	1,287
	Age-1	189	63	63
	Age-2	189	63	63
Spaulding Creek	Age-0	0	481	481
	Age-1	0	0	0
	Age-2	0	0	0
Camp Creek	Age-0	1,251	1,251	1,251
	Age-1	0	0	0
	Age-2	0	0	0
Meadow Lake	Age-0	2,550	0	0
	Age-1	137	46	46
	Age-2	30	10	10
East Twin Lake	Age-0	350	0	0
	Age-1	113	38	38
	Age-2	25	8	8
West Twin lake	Age-0	2,580	2,580	2,580
	Age-1	139	46	46
	Age-2	30	10	10

Parker Lake	Age-0	7,410	7,410	7,410
	Age-1	398	133	133
	Age-2	87	29	29

Within fish-bearing streams, stocking will commence at the furthest upstream location of suitable fish habitat. Some sections of waterbodies, such as areas above known passage barriers in Broadus, Scotty, and Blondie creeks, will not be stocked to maintain their fishless condition. After consideration of the MRDG (Appendix B), the section of the North Fork above the upper falls upstream of Dobrota Creek will not be stocked. Aerial stocking will be employed in the lakes, mainstem East Fork and North Fork, and larger tributary sections (Figure 15). Anticipated aerial stocking equipment includes an array of eight five- gallon tanks, an array of four seven-gallon tanks, and an array of two thirty-gallon tanks. The use of the different arrays will depend on stocking logistics and how many discrete locations will be used in each waterbody. Based on the proposed 2021 stocking cohort (Table 3), five helicopter trips with the four 7-gallon tanks will be needed for Age-0, five flights with an array of eight 5-gallon tanks will be needed for Age-1, and 20 flights with eight 5-gallon tanks will be needed for Age-2.

Where canopy cover limits the ability to stock from a helicopter, fish will be distributed on foot or by pack stock. Ideally, the first stocking event will occur in autumn after treatment has been completed. Although projects typically wait until the year following rotenone treatment to commence stocking, the presence of pure fish in the project area during the following spawning season will increase the effectiveness of swamping. Streams become neutralized shortly after rotenone application has dissipated, but the lakes remain toxic for longer. Therefore, stocking of the lakes will depend on the lakes being neutralized, so the stocking plans will be modified accordingly. We anticipate stocking during three years within the 5-year project window to ensure that multiple age-classes are well represented in the project area and to reduce the risk of a stocking cohort failure impacting the cumulative success of the stocking efforts.

2.2.12 Effectiveness Monitoring

Following completion of piscicide treatment, project partners may evaluate the effectiveness of the removal effort through electrofishing and collection of water samples to test for eDNA. Gillnets may be deployed in lakes. Furthermore, genetic analyses will assess changes in non-native trout admixture throughout the project area. These efforts may result in subsequent changes to the level and frequency of stocking in waterbodies not meeting conservation objectives.

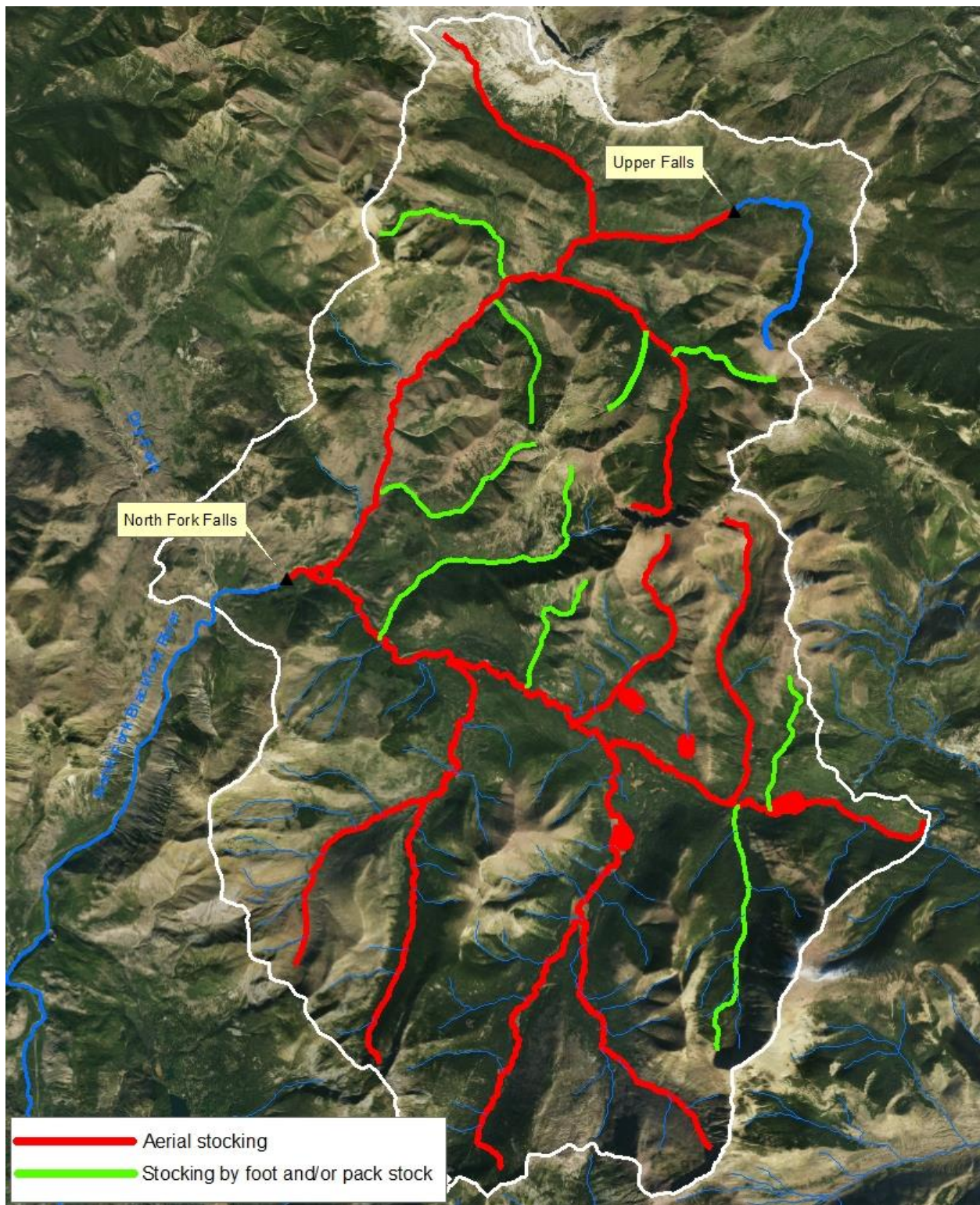


Figure 15. Map showing waterbodies proposed for aerial stocking (red) and waterbodies proposed for stocking by foot and/or pack stock only (green).

Literature Cited

- Clancey, P. T., B. B. Shepard, C. G. Kruse, S. A. Barndt, L. Nelson, B. C. Roberts, and R. B. Turner. 2019. Collaboration, commitment, and adaptive learning enable eradication of nonnative trout and establishment of native westslope cutthroat trout into one-hundred kilometers of Cherry Creek, a tributary to the Madison River, Montana. *American Fisheries Society Symposium* 91:589–647.
- Isaak, D., M. Young, D. Nagel, D. Horan, and M. Groce. 2015. The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century. *Global Change Biology*. 21:2540-2553.
- Finlayson, B., D. Skaar, J. Anderson, J. Carter, D. Duffield, M. Flammig, C. Jackson, J. Overlock, J. Steinkjer and R. Wilson. 2018. Planning and standard operating procedures for the use of rotenone in fish management – rotenone SOP manual. Second Edition. American Fisheries Society, Bethesda, Maryland.
- Leary, R. F., G. K. Sage, and F. W. Allendorf. 2006. Evaluation of stocking as a means of replacing introduced trout populations in lakes with westslope cutthroat trout. University of Montana Conservation Genetics Laboratory Report 06/1.
- Montana Fish, Wildlife & Parks (MFWP). 2017. Piscicide Policy. Montana Fish, Wildlife & Parks, Fisheries Division, Helena, Montana.
- Pierce, R., C. Podner, and P. Saffel. 2018. Aquatic and associated investigations to guide conservation planning for bull trout and westslope cutthroat trout in the North Fork Blackfoot River upstream of the North Fork Falls 2002-2017. Montana Department of Fish, Wildlife & Parks, Missoula, Montana.
- Shepard B.B, M.C. Boyer, R. Pierce, C. Endicott, S. Relyea, K. Staigmiller, A. Smith. 2018. Considerations in selection of Westslope Cutthroat Trout donor populations and methods and locations of translocation in the North Fork Blackfoot River watershed within the Scapegoat Wilderness. Report prepared for Montana Fish, Wildlife & Parks, Region 2, Missoula, Montana.